Secure Routine: A Routine-Based Algorithm for Drivers Identification

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October 15, 2020

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Who am I?

PhD Student at the "Dipartimento di Matematica e Informatica" of the "University of Catania", Italy.
Industrial PhD co-funded by CNR and ParkSmart

Goal

Identify driver and distinguish the vehicle's owner from other drivers exploiting sensors' vehicle data

Why?

- *Theft detection*. In 2019, around 56k vehicles were stolen in UK
- *Insurance companies*

How to identify drivers?

Identification is possible with classification of driver's behavioural.

Routine based classification

Classification based on how frequently actions are repeated in time.

Two persons may complete a task with similar action but with few important variations

Secure Routine

Panoramic

- Secure Routine (SR) learns what drivers do and how much frequently
- SR algorithm reads sensors' car data via OBD-II interface
- SR algorithm elaborates recorded data and extracts from timestamp second, minute, hours, day of week, day, month, year
- SR make use of Machine Learning (ML) algorithms to discover driver's routine and to identify the driver

Secure Routine

What differs from other identification solutions?

- Most identification algorithms do not look for frequency
- Previous solutions use same feature set for all drivers
- Many algorithms ignore timestamp component

Instead:

- SR selects best feature set for each driver
- SR decomposes timestamp in fine grained units

Secure Routine

Example

Alice and Bob are used to going on the Sixth Avenue. Alice usually take the road at 12PM and Bob at 7PM. If the vehicle is at 7PM on the Sixth Avenue, who is the driver?

- Without timestamp, the resulting model cannot answer unambiguously
- With timestamp, the resulting model says "The driver is Bob"

Secure Routine Algorithm

- *Model Generation Dataset* creates instances composed by (day, month, year, hour, minute, second and day of the week) plus sensors' car data
- *Feature Selection Paradigm* ranks the features applying the Gain Ratio and selects the best feature
- *Model Generation Algorithm* uses past instances to generate a vehicle's driver model
- *SR Identification strategy* evaluates if each instance belongs to vehicle's owner or to another driver

Secure Routine Evaluation

- [1] referred in the following as M
- [2] referred in the following as K
- [3] referred in the following as G

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[1] F. Martinelli, F. Mercaldo, A. Orlando, V. Nardone, A. Santone, and A. K. Sangaiah, "Human behavior characterization for driving style recognition in vehicle system,"

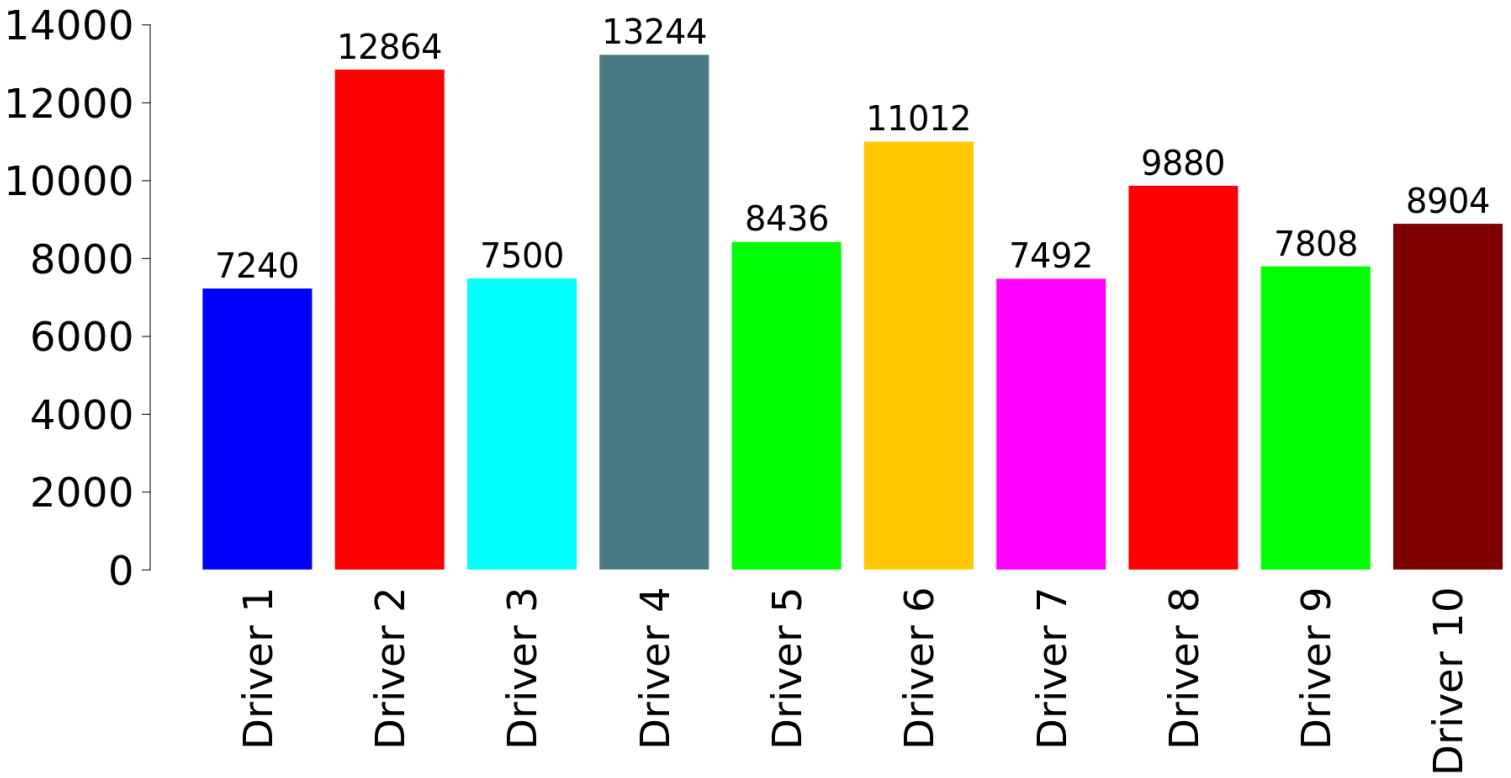
[2] B.-I. Kwak, J. Woo, and H. K. Kim, "Know your master: Driver profiling-based anti-theft method"

[3] A. Girma, X. Yan, and A. Homaifar, "Driver identification based on vehicle telematics data using lstm-recurrent neural network"

Secure Routine Evaluation

Datasets

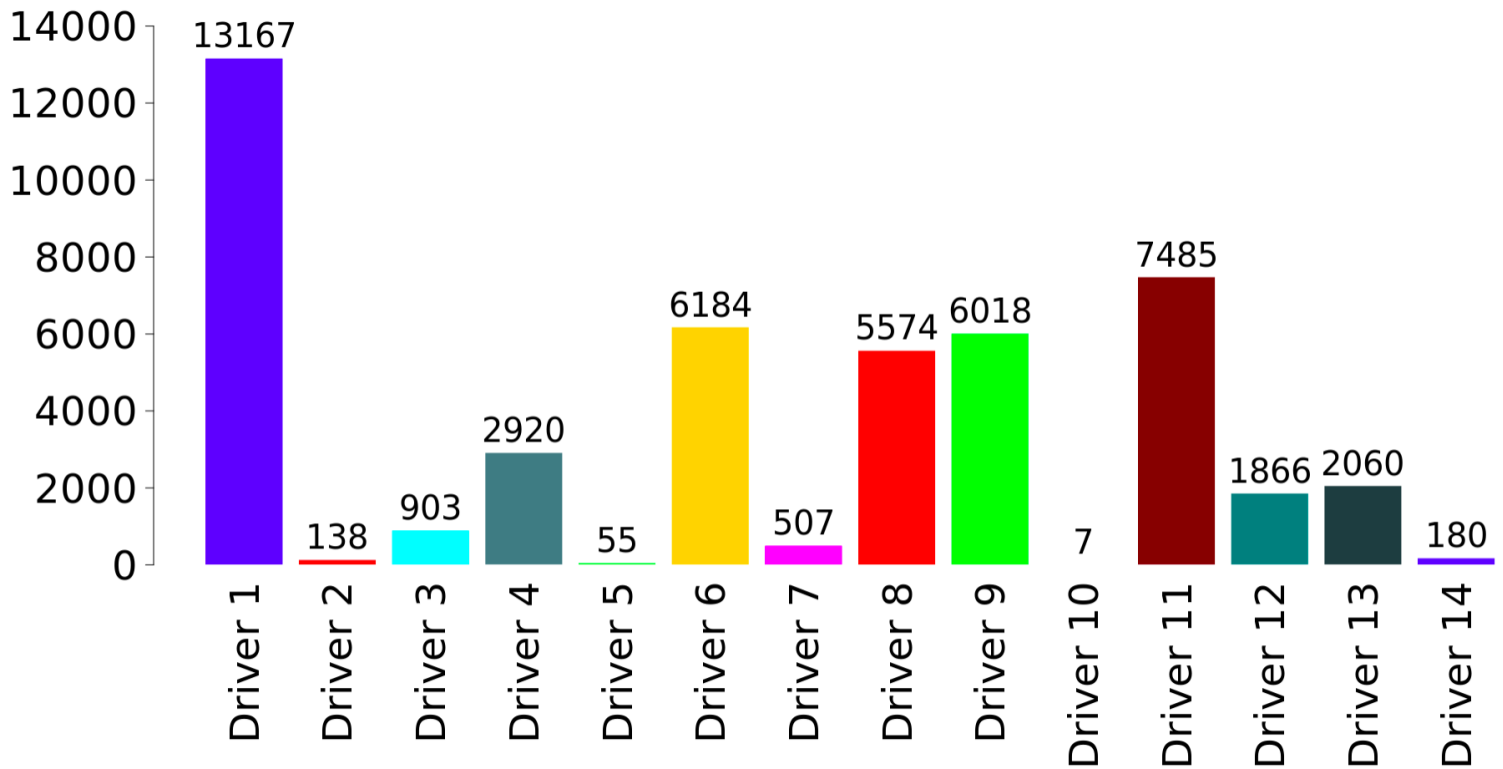
Dataset Θ:



Secure Routine Evaluation

Datasets

Dataset Ψ:



Experiments

Comparison of Secure Routine with M, K and G on Θ

Secure Routine		*M*		*K*		*G*	
Precision	Recall	Precision	Recall	Precision	Recall	Precision	Recall
99,6%	99,6%	99,2%	99,2%	N.A.	N.A.	98,8%	98,1%
Accuracy		Accuracy		Accuracy		Accuracy	
99,6%		99,2%		99,6%		N.A.	

Experiments

Comparison of Secure Routine with M on Θ

Secure Routine		M	
Avg. Precision	Avg. Recall	Avg. Precision	Avg. Recall
99,8%	98,5%	99,3%	99,3%

Experiments

Comparison of Secure Routine with M for multi-driver identification on Ψ

Secure Routine		M	
Precision	Recall	Precision	Recall
99,4%	99,4%	90,4%	89,8%

Experiments

Comparison of Secure Routine with M for owner identification on Ψ

Secure Routine		*M*	
Avg. Precision	Avg. Recall	Avg. Precision	Avg. Recall
99,6%	98,1%	95,1%	82,9%

Conclusions

- We introduced Secure Routine paradigm to identify the vehicle's owner
- We provide FSparadigm for feature selection
- SR the best results in comparison with the other algorithms

Conclusions

Thanks for your attention

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